REMARKS

Claims 1, 2, 4-6, 8-10, 12-30, 41-44, and 46 are pending. Claims 3, 7, 11 and 45 have been cancelled, without prejudice or disclaimer of the subject matter presented therein. Claims 2, 4, 8, 9, 10, 14, 22, and 23 have been amended to even further clarify the claimed subject matter, and Claim 46 has been amended to depend from Claim 9. Claims 1, 4-6, 9, and 41 are in independent form.

Claims 1-3, 12, 13, 16, 18-21, 23, and 25-30 were rejected under 35 U.S.C. 103(a) as being unpatentable over *Lau et al.* ("Field Emission from Metal-Containing Amorphous Carbon Composite Films", Diamond and Related Materials, Vol. 10, pp. 1727-1731) in view of International Publication No. WO 99/28939 (*Tuck et al.*).

Claims 4-11, 14, 15, 17, 22, 24, and 41-46 were rejected under 35 U.S.C. 103(a) as being unpatentable over *Lau et al.*, *Tuck et al.* and U.S. Patent No. 5,986,857 (*Hirano et al.*).

Independent Claim 1

Claim 1 recites:

> 1. An electron-emitting device comprising:
> a cathode electrode;
> a layer electrically connected to the cathode electrode; and
> a plurality of particles, each comprising as a main component a material which has resistivity lower than resistivity of a material of the layer, wherein
> the plurality of particles are arranged in the layer, and
> a density of the particles in the layer is 1×10^{14} particles/cm^3 or more and 5×10^{18} particles/cm^3 or less.

At page 11 of the Office Action, in the "Response to Arguments"section, the Office Action asserts that "While the applicant argues that Tuck discloses only a surface density (page 10), as opposed to the claimed volume density, the examiner asserts

that the surface density, combined with the disclosed thickness (page 7) teaches the claimed density".

However, while page 10 of Tuck may refer to "sites [that] may be distributed over the field electron emission material at an average density of at least 10^2 cm^{-2}" and to "sites [that] may be distributed over the field electron emission material at an average density of at least 10^3 cm^{-2}, 10^4 cm^{-2} or 10^5 cm^{-2}", these quantities represent a quantity of electron emission sites, and do not represent the number of particles in the layer, as apparently alleged in the Office Action. This can be understood in view of, for example, Figs. 2a and 2b of Tuck, showing a MIV emission model diagram as an electron emission mechanism (see, e.g., page 15, line 18 through page 16, line 24). In Fig. 2a, a conducting particle 223 is placed on an insulating layer 222 that is disposed on an electroconductive substrate 221. From a base of the particles 223, electrons are emitted. In Fig. 2b, a conducting particle 231 is disposed on an electroconductive substrate 230 in contact therewith. Each of the particles 231 is covered with an insulating layer 232 having a thickness 235 sufficiently smaller than a height 234 of the particles. And, an electron is emitted through a conducting channel 233 formed in the insulating layer 232 above the particle 231.

However, Tuck discloses merely a configuration wherein only one particle apiece (each separate particle) is arranged in a direction of the thickness of the insulating layer 232. This is apparent also from the above fact that each of the particles 231 is separately covered with an insulating layer 232 of thickness 235, which is sufficiently smaller than height 234 of the particles (see, e.g., page 16, lines 20-22 and page 7, lines 3-5 of Tuck).

Accordingly, even supposing for argument's sake that the above quantities referred to on page 10 of Tuck were to be deemed the number of particles, so long only one

particle apiece is arranged in the thickness direction of the insulating layer 232, the quantity values referred to on page 10 of Tuck would translate simply into a volume density range of, for example, 10^2 cm^3 to 10^5 cm^3. Such a value does not anticipate or render obvious that a density of particles in a layer is 1 X 10^{14} particles/cm^3 or more and 5 x 10^{18} particles/cm^3 or less, as set forth in Claim 1.

Moreover, even supposing for argument's sake that values such as, for example, 10^2 cm^{-2} to 10^5 cm^{-2}, referred to on page 10 of Tuck, do represent a number of particles, and that a calculation of volume density were to be performed according to the Examiner's apparent understanding, that calculation would be carried out as follows. The thickness of the insulation layer is 10^{-6}cm (10mm) -10^{-5}cm (100nm). Accordingly, the density would be {(10^2/cm^2)÷(10^{-6}cm or 10^{-5}cm)} to {(10^5/cm^2)÷(10^{-6}cm or 10^{-5}cm)}. This value would be (10^7/cm^3 or $10^8$$cm^3$) to ($10^{10}$/$cm^3$ or 10^{11} cm^3). Such a value also would not anticipate or render obvious that a density of particles in a layer is 1 x 10^{14} particles/cm^3 or more and 5 x 10^{18} particles/cm^3 or less, as set forth in Claim 1 herein. Indeed, nothing has been found, or pointed out, in Tuck, that would teach or suggest those features.

Page 3 of the Office Action concedes, and Applicants agree, that Lau et al. "do not disclose the emitter device or the density of particles in the layer", set forth in Claim 1.

Accordingly, because neither Lau et al. nor Tuck teaches or suggests the above recitations of Claim 1, that claim is clearly patentable over those references, whether considered separately or in combination.

Independent Claims 4 and 9

Independent Claim 4, as amended, recites as follows:

4. An electron-emitting device comprising:

a cathode electrode;
a layer which is arranged on the cathode layer and contains carbon as a main component; and
at least two particles which are arranged so as to be adjacent to each other in the layer and each of which comprises metal as a main component, wherein
one of the adjacent two particles is arranged to be nearer to the cathode electrode than the other particle, and
the metal is selected from the group consisting of Co, Ni, and Fe, and wherein
the layer contains hydrogen of 0.1 atm% or more and 20 atm% or less with respect to the carbon in the layer.

A notable feature of Claim 4 relates to the range of hydrogen quantity contained in a layer containing carbon as a main component, and containing particles of metal as a main component. The inventors have discovered that stress can be eliminated or substantially reduced in an electron-emitting device by regulating the amount of hydrogen contained in the layer to 0.1 atm% or more, and that, when a ratio of hydrogen to carbon is 20atm% or more, electron emission efficiency can be degraded. Thus, according to the device of Claim 1, a lower limit of the hydrogen content is set at 0.1 atm%, and an upper limit is set at 20atm%.

Also, among other notable features of Claim 4 is that one of the adjacent two particles is arranged to be nearer to the cathode electrode than the other particle.

According to Tuck, on the other hand, and as disclosed in Figs. 2a and 2b, all of the particles 223 are arranged substantially on a same plane formed by the surface of the element 222, and thus none of those particles can be closer to the component 18 (Tuck, Fig. 8) that is alleged to be a cathode by the Office Action. Indeed, nothing in Tuck would disclose or suggest a configuration in which one of the adjacent two particles is arranged to be nearer to the cathode electrode than the other particle, as set forth in Claim 4. .

Lau et al. is cited in the Office Action as teaching a layer comprising carbon as a main component, and a plurality of particles comprising metal selected from Co, Ni,

and Fe as a main components, wherein the plurality of particles are arranged in the layer. However, without conceding the propriety of those assertions, it is respectfully submitted that nothing has been found in that reference that is understood to teach or suggest what is missing from Tuck.

The Office Action relies on Hirano as disclosing "incorporating hydrogen into the atmosphere carbon film (as of Lau) in order to reduce internal stress". However, nothing in that reference is understood to teach or suggest what is missing from Tuck, relating to a configuration in which one of the adjacent two particles is arranged to be nearer to the cathode electrode than the other particle, as set forth in Claim 4.

Because neither Lau et al., Tuck, nor Hirano is seen to teach or suggest those features, even if those references were attempted to be combined in the manner proposed in the Office Action (assuming such a combination would even be permissible), the result still would not teach or suggest those features. Accordingly, Claim 4 is believed to be clearly patentable over those references, whether considered separately or in combination, for this reason alone.

Also, the Office Action alleges that "[i]t would . . . have been obvious to ... incorporate the hydrogen content disclosed by Hirano et al. Into the layer of Lau et al." This assertion also is respectfully disagreed with for the following reasons.

Col. 2, lines 47 to 58 of Hirano refers to a hydrogen-incorporated film being a hydrogenated amorphous carbon film, generally called a diamond-like carbon film. However, nothing has been found in Hirano that would teach or suggest that the layer contains carbon as a main component, let alone that the layer contains metal particles and hydrogen of 0.1 atm% or more and 20 atm% or less with respect to the carbon in the layer, as set forth in Claim 4. Moreover, although the Office Action addresses the foregoing range by broadly asserting that "[t]he optimization of parameters, absent evidence to the

contrary, has been held to be obvious to one of ordinary skill in the art at the time of the invention", the claimed range did not result from a mere parameter optimization, but instead resulted from the inventors unexpected discovery that the claimed range can be useful to eliminate or substantially reduce stress in an electron-emitting device, while at the same time maintaining (and without substantially degrading) the device's election emission efficiency. *See* MPEP 2144.05(III) ("'Applicant can rebut a presumption of obviousness . . . by showing . . . that there are new and unexpected results relative to the prior art.'") (citation omitted).

Moreover, Hirano is directed to a magnetic recording head. Claim 1, on the other hand, is directed to an electron-emitting device -- a completely different, non-analogous art. Moreover, the hydrogen content range set forth in Claim 1, in particular, the recited upper limit of the range, is related to a problem inherent to electron-emitting devices, not to magnetic recording heads. Accordingly, there would have been no reason why one skilled in the art, when faced with the above-described problem relating to electron-emitting devices, would have logically had his or her attention drawn to or consulted Hirano, let alone been motivated to attempt to combine it with Lau et al. and Tuck in the manner proposed in the Office Action.

For all of the above reasons, it is believed that the rejection of Claim 4 has been obviated, and that Claim 4 is clearly patentable over those references, whether considered separately or in combination. Accordingly, withdrawal of the rejection of Claim 4 is respectfully requested.

Independent Claim 9 recites, in part, that "the layer contains a hydrogen of 0.1 atm% or more and 20 atm% or less with respect to a carbon element." Because these recitations are the same as those of Claim 4, Claim 9 is also believed to be clearly

patentable over Lau et al., Tuck, and Hirano, for the same reasons as those given above with respect to those recitations.

Independent Claim 5, 6, and 41

Independent Claims 5 and 6 each recite, in part:

"one of the adjacent two particles is arranged to be nearer to the cathode electrode than the other particle, ..."

Claim 41 recites features substantially similar to the foregoing recitation.

For the reasons given above with respect to the similar recitations of Claim 4, nothing has been found, or pointed out, in either Lau et al., Tuck, or Hirano, that would teach or suggest those features. Accordingly, Claims 5, 6, and 41 are each believed to be clearly patentable over those references, whether considered separately or in combination.

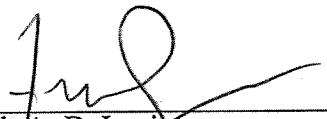
Dependent Claims

The other claims depend from one or another of the independent claims discussed above, and also are believed to be clearly patentable over the references relied on in the Office Action for the same reasons as are those respective independent claims. Since each dependent claim is also deemed to recite an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request early and favorable consideration and passage to issue of this application.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,



Frank A. DeLucia
Attorney for Applicants
Registration No. 42,476

FITZPATRICK, CELLA, HARPER & SCINTO
30 Rockefeller Plaza
New York, New York 10112-3801
Facsimile: (212) 218-2200

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